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recurring with great regularity. Examples,  $\beta$  Persei and  $\delta$  Cephei.

In order to avoid all prejudice, the present discussions are made to depend entirely on the work of previous observers, while awaiting the completion of more precise observations now in progress at Harvard College Observatory.

An investigation was given in the article referred to above, of stars of the fourth class. It was shown that in the case of  $\beta$  Persei at least, the observed variations could be very satisfactorily explained by the theory that the reduction in light was caused by a dark eclipsing satellite.

Variables of the third class are considered in the present paper. Perhaps the most natural supposition of the variability of a star of short period, is that it is due to rotation around its axis. The difference in brightness of the two sides of a star, which such an explanation demands, may be due to spots like those of our sun, to large dark patches, or to a difference in temperature. The theory that variation is due to the absorption of a rotating mass of gas, does not appear probable for stars of the third class, since no evidence of absorption is in general shown in their spectra, beyond the appearance of lines such as are seen in our sun. For the stars of the second class, however, this view seems more reasonable, since many of them exhibit spectra which are strongly banded.

"One great advantage of the study of the stars by physical instruments, as the spectroscope and photometer, is that some clew is given to certain laws, for our knowledge of which we must otherwise depend on theoretical considerations alone. While the conclusions to be drawn from micrometric measurements are, in general, much more precise, and the effects of the errors can be more certainly computed, they fail entirely to aid us in studying such laws as are here considered. For example, the present investigation serves to study the following important problem in cosmogony, to which micrometric measures contribute nothing, and which can otherwise only be examined from the standpoint of theory.

If we admit a common origin to the stars of the Milky Way, a general coincidence in their axes of rotation seems not improbable, especially as such an approximate coincidence occurs in the members of the solar system. If the coincidence was exact, the direction must be that of the poles of the Sun, or, approximately, that of the pole of the ecliptic. On the other hand, since the stars of the Milky Way are supposed to be arranged in the general form of a flattened disc, we should more naturally expect that the axes of rotation would be symmetrically situated with regard to it, or would coincide with its shortest dimension. According to this theory, then, the axes of rotation would be directed towards the poles of the Milky Way. If now we suppose that a great number of variable stars were distributed over the heavens, it is evident that those seen in the direction of their axes would not appear to vary, since, as they turned, they would always present the same portions of their surfaces to the observer. Those at right angles to this direction would show the greatest variation, and, other things being equal, would appear to be more numerous, since they would be more likely to be detected. If then the axes are coincident, we should expect that most of these variable stars would lie along the arc of a great circle whose pole would coincide with their axes of rotation."

"Thirty-one stars are known whose period is less than 72 days. Of those, six belong to the fourth class, or that of  $\beta$  Persei, in which the variation is probably due to the interposition of an opaque eclipsing satellite. Of the remainder, seven may be excluded, since they are red, and may belong to the second class, or that of  $\alpha$  Ceti. Eighteen remain, whose periods vary from less than a day to 54 days, and which may be placed in the third

class. All lie within  $16^\circ$  of a circle whose pole is in R. A. 13h, Dec.  $+20^\circ$ . The distances of eleven are from  $0^\circ$  to  $5^\circ$ , of five at distances of  $8^\circ$  and  $9^\circ$ , one at  $14^\circ$  and one at  $16^\circ$ . The average distance is  $5.5^\circ$ , while, if the stars were distributed at random it should be  $30^\circ$ ."

THE dome erected by Sir Henry Bessemer for the reception of his new and powerful telescope is now nearly finished. The telescope itself has arrived from the makers, and is now ready to be set up. It has been constructed on a plan devised by Sir Henry Bessemer, which it is believed will permit of telescopes being made on a much larger and more powerful scale than even the present one, which is the largest in the world. The present instrument is capable of being directed to any part of the heavens at the option of the observer. The upper portion of the dome is made of glass, with windows facing in every direction, and within there will be placed mirrors of silvered glass, which is part of the new invention, silvered glass being used in place of metal. The room and dome with its windows will revolve and keep pace automatically with every motion of the telescope, and the upper end of the instrument will reach a height of about forty-five feet.

WASHINGTON, March 24.

W. C. W.

#### DISCREPANCY IN RECENT SCIENCE.

There are two classes of statements in current scientific literature that do not harmonize. Their teachings are opposite; yet, the sayings are daily used by men who believe both to be true. One series of doctrines is known as the "Conservation of Energy;" the other, the "Nebular Hypothesis." The structure of nature rests on one, while the history of cosmic evolution is based on the other. Then they should agree. Men are fascinated with cosmogony, and for ages have sought the laws by which the Universe developed. This research culminated in the existing Nebular Hypothesis. Other fields of study were opened, man scrutinized his environment, analyzed matter, searched for its ruling laws and summed up results in the doctrine of the Conservation of Force. Now the laws by which nature was in the past evolved, and is in the present governed, must be, and are the same. Such does not seem to be the teaching of some late popular books on science.

By a generalization of late research it is announced that the Universe is a unit. All suns visible in the telescope are composed of similar material, since they emit light, having like properties, and are dominated by the same laws of gravity and motion as rule the solar system.

Like matter, like laws, is the postulate of nature for all time. Some scientists ignore this apparent truth, as will be seen in comparing ideas advanced in recent works.

The fundamental axiom in the law of the interaction of force is, that when one mode of energy appears, another vanishes, and vice versa.

No form of force can become sensible without the retirement of another of equal intensity. This mutual displacement never ceases for an instant, and the system of nature is kept up by the flow, interchange and conversion of force. Conservation is the law of energy, and no one force can long act without waning and giving rise to another. Gravity, motion, electricity, magnetism, chemism, heat and light, are forms in which energy exists; yet one never can work eternally by itself, but must suffer conversion into another mode of power. Motion in molecules evolves heat, and heat acting upon still molecules appears as motion. Chemism acts, gives rise to heat and in doing so expires; or it may exhaust its energy in conserving electricity, which in turn may develop into heat. Numberless like instances might be given to prove the conservation of energy, were they necessary, but they are not; this great law is universally accepted by students of nature throughout the world, and the closest reasoner cannot find objection to this deduction of science. Among many facts revealed by the discovery of the laws of force, one only is

here sought to be made prominent, that relating to the evolution of heat. Heat cannot come of itself; some other mode of energy must precede it. Suppose all matter in existence to be dissociated, resolved to gas so attenuated that no two atoms touch. It would have "potency" for future development of every form of force, but at that time only one would be in existence—gravity. It could reign supreme only for an instant; obeying the law, it would suffer "conservation," and give rise to motion.

Hence, motion is the second mode of energy, and all the heat that ever existed came later. The only sources of heat known are motion and chemical action, itself a most rapid motion. Gravity caused the movement of original atoms, bringing them near enough to be within the influence of affinity, which acting, conserved heat, the fourth form of force awakened in the evolution of atoms hitherto separated. Or a little heat might have been derived from collision of atoms not having affinity; in either case heat had antecedent forces. Heat is not a primal affection of matter, but secondary; being always preceded by gravity and motion. And molecules must be separated by space in order that gravity can cause motion to appear and vanish in heat. It is not conceivable that primordial dissociated matter should have obeyed any impulse at first, save gravity, then motion, then Chemism, then heat and subsequently all other states of force.

The Nebular Hypothesis seeks to account for the evolution of all solar systems from primordial dissociated matter, requiring as Helmholtz says: "Several cubic miles to weigh a single grain." Nearly all physicists accept this theory, and admit that all existing matter was once in this condition of gas. It seems, by reason of known laws of matter, to be true. Thus, no two atoms coalesced; they were as far apart in proportion to their diameters, as the Sun and Polaris. No ascertained law of nature disputes this theory; and within limits of human knowledge, it must be so. Matter dissociated is in its most primitive condition; and nature begins in simplicity and develops complexity. Matter in fluid states is complex, and shows itself to have been wrought by force. All analogy points to the fact that at one time in the history of matter, its atoms were entirely separated; in which condition no force whatever save gravity was in existence to act thereon.

Yet, strange to say, some advocates of the nebular theory teach that this rare gas was intensely hot! They call it "fire mist,"<sup>1</sup> and aver that it was hotter than the sun is now! We read<sup>2</sup>; "There was a time when the materials composing it (the Universe), were masses of glowing vapor," and "we find that the further we go back into time the hotter the sun must have been. Since we know that heat expands all bodies, it follows that the sun must have been larger in past ages than it is now, and we can trace back this increase in size without limit. Thus we are led to the conclusion that there must have been a time when the sun filled up the space now occupied by the planets, and must have been a very rare mass of glowing vapor." True, the materials of the sun extended into a ball of gas thousands of millions of miles in diameter, far lighter than hydrogen; but the gas was intensely cold. No law of matter or force known to man; nor any analogy in nature leads to the conclusion that the primitive cosmical sphere of atoms was hot. It was cold and dark, neither chemism, heat, or light appeared until gravity made conservation in motion, making chemical action possible. Affinity must have been slow at first, so that heat could not have appeared until after ages of chemical and molecular activity had expired, and heated fluid nuclei begun to condense and shine. The original cosmical mass was as dark, cold and silent as interstellar space is now, and "fire mist" never had a place in nature. If the

primeval "glowing vapor" ever existed, then the greatest monument ever reared by man, the "Law of Interaction of Force" falls crumbling to final ruin.

EDGAR L. LARKIN.

NEW WINDSOR OBSERVATORY, Ill., March 21, 1881.

## NOTES.

**SOLUTION OF STARCH.**—Zulkowsky proposes to make starch perfectly soluble in water by heating it to 190° C. along with glycerine. This process is most successful with potato-starch, less so with wheat-starch, and very difficult with rice-starch.

**SALICYLIC ACID IN TEXTILE MANUFACTURES.**—Dr. F. von Heydon recommends salicylic acid to be applied in dilute solution to woollen yarns, and to be mixed with sizes to prevent mildew, unpleasant smells, &c. Five grms. acid are sufficient for a litre of size.

**ACTION OF HYDROCHLORIC ACID UPON METALLIC CHLORIDES.**—The chlorides which are rendered more soluble by hydrochloric acid are divided into two groups; the one (*e.g.*, mercuric chloride) exceedingly soluble in the concentrated acid form with its crystalline compounds; the other (*e.g.*, silver chloride) very sparingly soluble, even when heated, yield on cooling the chloride considered as anhydrous.—A. DITTE.

**ACTION OF CAUSTIC LIME UPON PURE SOLUTIONS OF SUGAR AND RAW BEET-JUICE.**—If free alkalies or alkaline earths are added to a solution of sugar the rotation which sugar occasions in polarized light decreases, and is restored on neutralizing the alkaline liquid with acetic acid.—F. DESOR.

**NEW STUDIES ON THE PART PLAYED BY BONE-BLACK IN THE SUGAR MANUFACTURE.**—Free lime is almost entirely absorbed by bone-black. Salts of lime and potash are also absorbed to a certain extent. Potash and lime, the latter in saline form, promote each other's absorption.—H. PELLET.

**CHEMICAL CHANGE OF STARCH ON EXPOSURE TO STEAM AT A HIGH PRESSURE.**—A heat of 140° to 150°, and consequent pressure of 3½ to 4½ atmospheres convert 71 per cent. of starch into glucose. Dr. M. Stumpf considers that with the aid of 1 to 2 parts of acid per thousand saccharification may be carried so far as to render the use of malt unnecessary.

**DECOMPOSITION OF SALTS BY LIQUIDS.**—The laws of dissociation by heat, applicable to the decomposition of salts by pure water and saline acid solutions, apply also to decomposition by alcohols.—A. DITTE.

**INFLUENCE OF THE SOIL UPON THE TANNIN OF OAK BARK.**—A comparison was made between the bark of young oaks grown respectively upon sandy loams, upon peaty soil which had been once burnt, and upon a similar soil thrice burnt. The proportion of tannin was found higher in case of the peaty soils.—M. FLEISCHER.

**INFLUENCE OF MANURES ON THE APPEARANCE OF DISEASE AND THE PROPORTION OF STARCH IN POTATOES.**—Three plots dressed with stable manure showed 6, 6, and 5 per cent. of diseased tubers. Plots where superphosphate and small quantities of ammoniacal superphosphate were used did not increase the percentage, but with larger proportions of the latter it rose to 8 per cent. Chili saltpetre was attended by a proportion of 11 per cent., and when used as a top-dressing 12 per cent.—M. MARCKER.

**INFLUENCE OF BORAX ON THE DECOMPOSITION OF ALBUMEN IN THE ANIMAL ORGANISM.**—The ingestion of borax is found to increase the decomposition of albumen.—M. GRUBER.

**TITRATION OF BISMUTH SUBNITRATE.**—This process is based upon the facts that as to 9.9074 gm. of monohydrated sulphuric acid correspond to 1 gm. anhydrous nitric acid these two weights of acids will require the same quantity of alkali for exact saturation, and that bismuth subnitrate is capable of yielding all its nitric acid to an excess of alkali on boiling.—E. BAUDRIMONT.

<sup>1</sup> Winchell's Geology of the Stars.

<sup>2</sup> Newcomb and Holden's Astronomy, p. 494.